REVIEW ARTICLE

Adult intussusception: a systematic review and meta-analysis

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Abstract

Background Perhaps partly because intussusception in adults is rare, optimal treatment remains controversial. The aim of this study was to determine the appropriate surgical procedure for adult intussusception.

Methods A systematic search was undertaken using PubMed, Embase, and Web of Science from 1/1980 to 12/2016. Adults (> 15 years) with intussusception treated by surgical or conservative measures were included.

Results One thousand two hundred twenty-nine patients were identified from 40 retrospective case series. Pooled rates of malignant and benign tumors and idiopathic etiologies were 32.9% (95% CI 28.6–37.4), 37.4% (95% CI 32.7–42.3), and 15.1% (95% CI 11.7–19.3), respectively. Pooled rates of enteric, ileocolic, and colonic location types were 49.5% (95% CI 41.8–57.2), 29.1% (95% CI 23.0–36.1), and 19.9% (95% CI 16.3–24.1), respectively. Pooled rates of malignant tumors in enteric, ileocolic, and colonic intussusception were 22.5% (95% CI 18.3–27.3), 36.9% (95% CI 27.3–47.6), and 46.5% (31.1–62.6), respectively. Metastatic carcinoma was the main cause of malignant tumor in enteric intussusception. Conversely, primary adenocarcinoma was the main cause of malignant tumor in ileocolic and colonic intussusception. Considering the high rate of malignancy of colonic intussusception the majority of the studies surveyed recommend en bloc resection without reduction to avoid potential intraluminal seeding or venous tumor dissemination. Pooled rates of postoperative complications and mortality were 22.1% (95% CI 17.5–27.5) and 5.2% (95% CI 3.7–7.4), respectively.

Conclusion Whereas enteric intussusception can be managed by reduction followed by resection, colonic intussusception should be resected en bloc. Due to the intermediate forms between enteric and colonic intussusception, a selective approach is recommended. Surgery remains the mainstay in adult intussusception.

Keywords Adult intussusception · Enteric type · Colonic type · Ileocolic type

Introduction

Intussusception is described as invagination of a segment of bowel into the lumen of an adjacent segment. Intussusception in adults is rare and has various clinical presentations when compared to the pediatric form [1]. Intussusception is difficult to preoperatively diagnose, despite the evolution of imaging procedures [2, 3]. Intussusception in children is typically idiopathic, thus nonoperative reduction is usually sufficient treatment. Adult intussusception, however, more commonly involves a pathologic lead point, and up to 57% of reported cases are attributable to a malignant tumor [4, 5]. Although surgery is the recommended treatment for adult intussusception, the optimal surgery remains controversial. Although abdominal computed tomography (CT) scan has proven useful in diagnosing intussusception, it has limited value in discriminating whether a lead point is malignant, benign, or idiopathic [6–8]. Reduction at surgery may avoid excessive bowel resection, although it can theoretically increase the risk of potential intraluminal seeding or venous tumor dissemination.

The aim of this study was to determine what the appropriate surgical procedure for adult intussusception is, depending on location of the intussusception or other specific situations.

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Methods

Literature search strategy

A systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Guidelines provided by an international study group in 2009 [9]. PubMed, Embase, and Web of Science databases were searched using the date range of January 1980 to December 2016. The key words searched were "intussusception" AND "adult". Reference lists of identified articles were screened for additional publications of interest. Two reviewers (JK and WJ) independently reviewed all records by title and abstract, followed by review of the full-text article for those that met the screening criteria.

Eligibility criteria

Inclusion criteria consisted of adult (> 15 years of age) intussusception treated by either surgical or conservative measures. Reports of randomized controlled trials (RCT), cohort studies, case–control studies, and case series were included. The review was restricted to articles published in the English language. When the same cohort was included in more than one study, only the most recent publication with long-term follow-up was included. Case reports that included < 10 patients or patients younger than 15 years of age were excluded. Reports that included patients with rectal or stomal prolapse, animal studies, conference reports, abstracts without associated peer-reviewed publication, and review articles without original data were also excluded.

Data extraction and quality assessment

All articles selected for full-text review were distributed between two reviewers (JK and WJ), who independently decided on inclusion or exclusion and extraction of the study data. Any discrepancies in agreement were resolved through discussion and consensus. For the purpose of this review, intussusception was classified by etiology (benign, idiopathic, and malignant lesions) and by location (enteric, ileocolic, and colonic types) [10–14]. Enteric and colonic intussusceptions were considered as those confined to the small bowel and colon, respectively. Ileocolic intussusception was defined as involving both the small bowel and colon. Clinically (prior to reduction of the invaginated bowel), it is difficult to differentiate whether the lead point in ileocolic intussusception is located in the ileum or colon. Thus, the above classification is reasonable to consider any association between pathologic cause and location and to preoperatively or intraoperatively determine treatment plans. [10].

Information regarding the demographic characteristics of study subjects, diagnostic methods, type of intussusception, pathology of lead points, reduction status, operative methods, recurrence, and the authors' views on how to treat adult intussusception was extracted from each study report and tabulated in Microsoft Excel. Recurrence rates were calculated based on an intent-to-treat basis (the number of recurrences was divided by the number of initial enrolled patients, irrespective of surgery, excluding patients who were lost to follow-up). In cases where the number of patients lost to follow-up was not reported, initially enrolled patients were considered as the denominator.

Appraisal of study quality was undertaken using a checklist based on the Newcastle–Ottawa Scale [15] and included adequate case definition using appropriate diagnostic work up; clear patient selection with consecutive or obviously representative case series, if possible; control group for comparison; adequate postoperative outcomes including postoperative complications or recurrence; adequate follow-up defined as following at least 75% of the initial study population at the last follow-up. A quality score was determined for each study, with a maximum score of five indicating the highest quality study design.
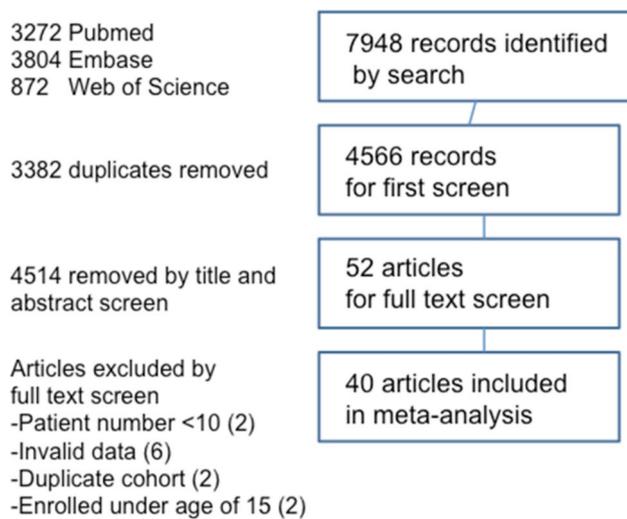
Data analysis

A single weight-adjusted mean or proportion for each variable or outcome was computed for each of the nonrandomized studies. A random effect model was used to derive pooled estimates of proportions with a 95% confidence interval (CI) for each outcome explored. Data pooling was conducted using Comprehensive Meta-analysis Version 2.0 (Biostat, Englewood, NJ, USA). Sensitivity analysis was conducted to identify the impact of the study period (< 2000, ≥ 2000 to 2009, ≥ 2010), if any, on the etiology of adult intussusception. In studies that did not report means and/or standard deviations (SDs), improvement rates were estimated from reported medians and ranges using the method described by Hozo et al. [16]. In studies that reported means without ranges, the SD was computed from the mean of SDs, as reported in other studies. A $p < 0.05$ was considered significant. The statistical index for heterogeneity assessment was tau. (2).

Results

Study selection and characteristics

Forty full-text articles were retrieved from among 7948 records (Fig. 1). All 40 were retrospective case series [2–8,

3272 Pubmed
3804 Embase
872 Web of Science

7948 records identified by search

3382 duplicates removed

4566 records for first screen

4514 removed by title and abstract screen

52 articles for full text screen

Articles excluded by full text screen
-Patient number <10 (2)
-Invalid data (6)
-Duplicate cohort (2)
-Enrolled under age of 15 (2)

40 articles included in meta-analysis

Fig. 1 Systematic review flow diagram for adult intussusception

10–13, 17–44] that included data on 1229 eligible patients. There were no randomized controlled or case control studies. Eleven studies [17–27] were published before 2000, 14 [2, 10, 11, 28–38] were published between 2000 and 2009, and 15 [3–8, 12–14, 39–44] were published after 2010. Six studies [14, 22, 29, 33, 36, 41] were conducted in tropical countries (Nigeria, Singapore, Ethiopia, Malaysia, Egypt, and Saudi Arabia). Studies had slightly different exclusion criteria: rectal intussusception, rectal prolapse, stoma site prolapse, or gastroenterostomy site intussusception. Some studies excluded intussusception related with prior surgery such as adhesion, gastroenterostomy or enteroenterostomy [6, 11, 18, 20, 21, 23, 26–28, 30, 33–35, 38, 42]. Some studies excluded incidental intussusception without symptoms [18, 44]. However, rectal intussusception, rectal prolapse, stoma site prolapse were not included consistently in all studies included in this review. The weighted mean age of all patients was 47.8 years (95% CI 44.8–50.8). The weighted percentage of males was 50.9% (95% CI 47.4–54.4). Study characteristics and quality of scores are summarized in Table 1. Pain was the most common symptom, with a pooled rate of 82.6% (95% CI 75.6–87.9). Other symptoms included nausea, vomiting, failure to pass gas, hematochezia, abdominal mass, diarrhea, and fever (Table 2).

Preoperative diagnostic methods

Preoperative diagnostic methods for intussusception included abdominal computed tomography (CT) scan, abdominal ultrasonography, small bowel series, barium enema, and colonoscopy. Among these, CT and ultrasonography were the most commonly used. Abdominal CT scan showed a typical bowel-within-bowel appearance for intussusception. Twenty eight studies [2–5, 7, 8, 10–14, 23,

26–28, 30–35, 38–44] reported the accuracy of preoperative CT scan in diagnosing intussusception, with a pooled accuracy of 77.8% (95% CI 71.9–82.9) (Fig. 2). Preoperative abdominal ultrasonography was performed in 26 studies [2–5, 7, 8, 10–13, 23, 27, 28, 30–36, 39, 40, 42–45] with a pooled accuracy of 49.2% (95% CI 41.7–56.8). Ten studies [4, 10, 12, 18, 23, 27, 32, 34, 35, 39] reported the accuracy of preoperative small bowel series, with a pooled accuracy of 35.9% (95% CI 24.7–48.9). Fourteen studies [4, 5, 10, 11, 18, 21, 23, 26, 27, 32–34, 39, 44] reported the accuracy of barium enema, with a pooled accuracy of 59.4% (95% CI 49.2–68.9). Eighteen studies [2–5, 10–12, 14, 18, 30, 32–35, 38, 39, 42, 44] performed colonoscopy, with a pooled accuracy of 52.6% (95% CI 40.9–64.0). Overall, intussusception was preoperatively diagnosed at a pooled rate of 58.3% (95% CI 47.7–68.1).

Etiologies and types

According to the etiology of adult intussusception, the pooled rates of malignant tumor, benign tumor, and idiopathic causes were 32.9% (95% CI 28.6–37.4), 37.4% (95% CI 32.7–42.3), and 15.1% (95% CI 11.7–19.3), respectively (Fig. 3). The pooled rates of enteric, ileocolic, and colonic locations were 49.5% (95% CI 41.8–57.2), 29.1% (95% CI 23.0–36.1), and 19.9% (95% CI 16.3–24.1), respectively. When dividing etiologies by location, the pooled rates of malignant tumor in enteric, ileocolic, and colonic types were 22.5% (95% CI 18.3–27.3), 36.9% (95% CI 27.3–47.6), and 46.5% (31.1–62.6), respectively (Fig. 4). The pooled rates of benign tumors in enteric, ileocolic, and colonic locations were 39.4% (95% CI 28.7–51.2), 34.4% (95% CI 25.8–44.1), and 36.8% (95% CI 26.2–48.7), respectively. The pooled rates of idiopathic etiologies in enteric, ileocolic, and colonic locations were 23.5% (95% CI 16.9–31.6), 23.0% (95% CI 14.2–35.0), and 20.2% (95% CI 13.6–28.9), respectively. Table 3 demonstrates types of malignant tumors according to location. Metastatic carcinoma was the main cause of malignant tumor in the enteric manifestation (pooled rate, 48.7% and 95% CI 31.8–66.0). Conversely, primary adenocarcinoma was the main cause of malignant tumor in ileocolic (pooled rate, 61.7% and 95% CI 46.1–75.3) and colonic intussusception (pooled rate, 78.8% and 95% CI 64–88.6). Fifteen studies [2–4, 10, 13, 14, 17, 26, 28, 29, 36, 37, 40] reported ischemia in the intussuscepted bowel, with a pooled rate of intestinal ischemia of 15.0% (95% CI 9.1–23.7).

Treatment

In 27 of the 40 studies, all patients had surgery for intussusception [2–4, 7, 8, 10, 12, 14, 17, 20–23, 25, 26, 28–31, 33, 36–38, 40, 41, 43]. Overall, 97 patients had conservative treatment without surgery. Fifty-nine of the 97 showed

Table 1 Included study characteristics

First author	Year	Country	Initial no.	Preoperative diagnosis	No. of procedures	Reduction prior to resection	En-bloc resection	Malignant tumor on lead point	QS
Coleman [17]	1981	Australia, England	17	n.a	17	n.a	n.a	9	2
Nagorney [18]	1981	USA	48	17	45	16	23	22	4
Agha [19]	1986	USA	25	n.a	n.a	n.a	n.a	8	2
Reijnen [20]	1989	Netherlands	20	10	20	5	11	6	3
Hamaloglu [21]	1990	Turkey	22	n.a.	22	n.a.	n.a	4	3
Nmadu [22]	1992	Nigeria	16	1	16	n.a	n.a	1	3
Azar [23]	1997	USA	58	19	58	n.a	n.a	27	3
Begos [24]	1997	USA	13	6	12	8	1	5	2
Matter [25]	1997	Israel	13	1	13	1	11	4	3
Yen [26]	1997	Taipei	21	n.a	21	7	12	5	3
Eisen [27]	1999	USA	27	11	24	10	13	12	2
Huang [28]	2000	China	45	n.a	45	n.a	n.a	16	3
Ugwu [29]	2001	Nigeria	22	n.a	22	0	16	4	3
Omori [11]	2003	Japan	11	9	9	3	3	3	3
Erkan [30]	2005	Turkey	13	4	13	9	3	4	3
Balik [31]	2006	Turkey	18	11	18	n.a	n.a	2	3
Barussaud [32]	2006	France	44	23	43	13	17	19	3
Goh [33]	2006	Singapore	60	n.a	60	4	54	28	3
Zubaidi [34]	2006	Canada	22	3	21	n.a	n.a	8	2
Chang [35]	2007	Taiwan	46	41	44	n.a	n.a	11	4
Kotisso [36]	2007	Ethiopia	25	9	25	0	19	2	3
Palanivelu [37]	2007	India	14	14	14	8	6	2	4
Wang [10]	2007	Taiwan	24	18	24	13	11	9	3
Wang [2]	2009	China	41	27	41	21	18	12	4
Yakan [38]	2009	Turkey	20	14	20	9	5	4	3
Ghaderi [12]	2010	Iran	15	7	15	n.a	n.a	2	3
Guillén [39]	2010	Spain	14	12	10	0	10	6	3
Hanan [4]	2010	Brazil	16	9	16	n.a	n.a	8	3
Rehman [13]	2010	Pakistan	19	10	18	11	3	5	3
Gupta [40]	2011	India	27	n.a	27	n.a	n.a	11	3
Onkendi [6]	2011	USA	196	n.a	120	13	99	43	3
Siow [41]	2011	Malaysia	14	n.a	14	3	11	7	2
Sarma [42]	2012	India	15	n.a	12	0	n.a	6	2
Cakir [8]	2013	Turkey	47	n.a	47	35	12	17	3
Gomes [7]	2013	Portugal	16	n.a	16	0	n.a	6	4
Kim [43]	2014	Korea	33	28	33	6	10	13	2
Mostafa [14]	2014	Egypt, Saudi Arabia	14	14	14	9	5	2	3
Honjo [5]	2015	Japan	44	42	41	n.a	5	25	2
Ozogul [3]	2015	Turkey	31	23	31	3	24	2	3
De Clerck [44]	2016	Belgium	43	n.a	31	8	12	13	4

QS quality of score, *n.a* not available

spontaneous reduction without any further interventions. The pooled rate of patients with conservative treatment was 4.6% (95% CI 2.7–7.7). The type of surgical intervention varied and was determined by the patient's medical history, tumor location, intraoperative findings, and surgeon's preference.

Thirty-three studies reported whether a reduction should be performed at surgery, prior to resection. Five studies [7, 12, 23, 25, 39] reported that all adult intussusceptions should be resected without reduction due to concerns of potential seeding of malignant tumor cells during manipulation.

Table 2 Symptoms and signs of intussusception

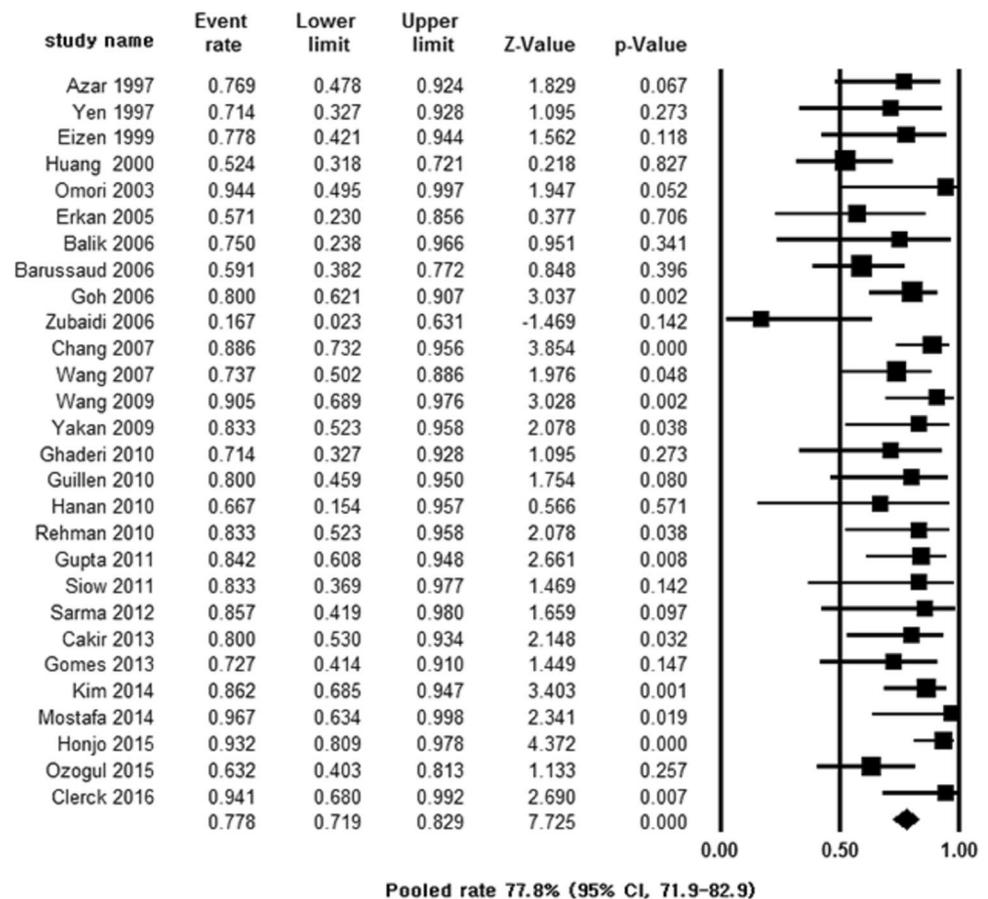| Symptoms and signs	Range of proportions reported by primary studies, %	Pooled proportion, %	95% CI (%)
Pain	15–100	82.6	75.6–87.9
Nausea or vomiting	12–100	49.7	42.0–57.5
Absence of gas	6–74	35.9	23.9–49.9
Abdominal mass	4–63	21.9	16.9–27.9
Diarrhea	7–41	20.1	15.8–25.2
Hematochezia	0–54	18.9	14.7–24.1
Fever	4–29	13.9	10.5–18.2

Conversely, six studies [5, 11, 13, 20, 22, 36] recommended that reduction should be attempted prior to resection regardless of location if there is no ischemic change or if a primary malignant lesion is not strongly suspected. Twenty-two [2, 4, 8, 10, 14, 18, 21, 24, 26, 27, 30–35, 38, 40–44] studies used selective approaches according to the location of the intussusception and suggested that colonic intussusception should be resected en-bloc without reduction; however, enteric lesions can be preliminarily reduced prior to resection to prevent excessive bowel resection. Only five studies

[4, 40–43] reported on a surgical plan for ileocolic intussusception, recommending resection without attempting to reduce the invaginated bowel. Data pooling were conducted for the following surgical procedures: (1) primary resection without reduction, (2) initial reduction followed by resection, (3) reduction alone, (4) enterotomy and mass excision, and (5) negative exploration. The pooled rates were as follows: 50.1% (95% CI 39.4–60.7), 31.1% (95% CI 22.2–41.7), 8.8% (95% CI 6.4–12.0), 5.2% (95% CI 3.4–7.7) and 3.8% (95% CI 2.2–6.2), respectively.
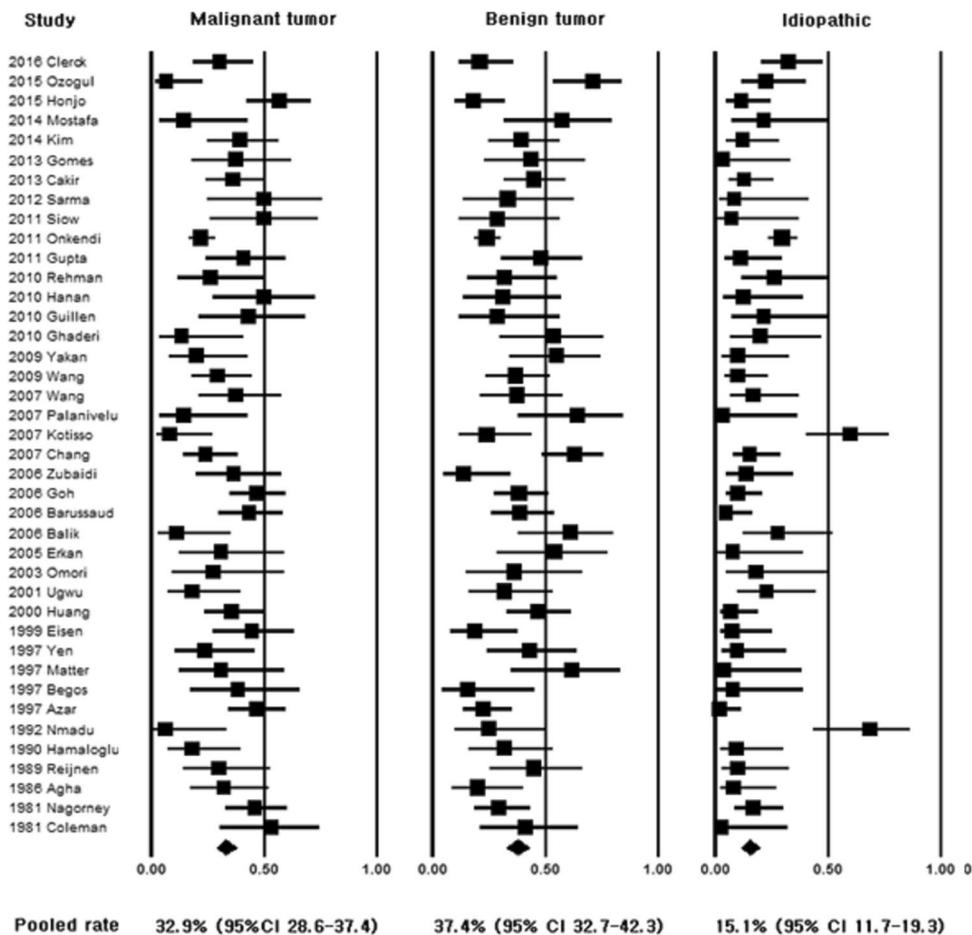
Complications and recurrence

Twenty studies reported postoperative complications [3, 4, 7, 10–12, 14, 18, 20, 21, 29–33, 36–40]. Among 464 patients who had surgery, 92 complications occurred. The pooled rate of postoperative complications was 22.1% (95% CI 17.5–27.5). More than half of the reported complications were surgical site infections. Other complications included pulmonary atelectasis, pneumonia, pulmonary thromboembolism, deep vein thrombosis, wound dehiscence, gastrointestinal bleeding, ileus, acute tubular necrosis, and cardiac arrhythmia. Twenty-eight studies reported postoperative mortality [2, 4, 5, 7, 8, 10, 11, 14, 17, 18, 20–23, 26, 29–40,


Fig. 2 Forest plot showing the accuracy of abdominal computed tomography for adult intussusception

study name	Event rate	Lower limit	Upper limit	Z-Value	p-Value
Azar 1997	0.769	0.478	0.924	1.829	0.067
Yen 1997	0.714	0.327	0.928	1.095	0.273
Eizen 1999	0.778	0.421	0.944	1.562	0.118
Huang 2000	0.524	0.318	0.721	0.218	0.827
Omori 2003	0.944	0.495	0.997	1.947	0.052
Erkan 2005	0.571	0.230	0.856	0.377	0.706
Balik 2006	0.750	0.238	0.966	0.951	0.341
Barussaud 2006	0.591	0.382	0.772	0.848	0.396
Goh 2006	0.800	0.621	0.907	3.037	0.002
Zubaidi 2006	0.167	0.023	0.631	-1.469	0.142
Chang 2007	0.886	0.732	0.956	3.854	0.000
Wang 2007	0.737	0.502	0.886	1.976	0.048
Wang 2009	0.905	0.689	0.976	3.028	0.002
Yakan 2009	0.833	0.523	0.958	2.078	0.038
Ghaderi 2010	0.714	0.327	0.928	1.095	0.273
Guillen 2010	0.800	0.459	0.950	1.754	0.080
Hanan 2010	0.667	0.154	0.957	0.566	0.571
Rehman 2010	0.833	0.523	0.958	2.078	0.038
Gupta 2011	0.842	0.608	0.948	2.661	0.008
Siow 2011	0.833	0.369	0.977	1.469	0.142
Sarma 2012	0.857	0.419	0.980	1.659	0.097
Cakir 2013	0.800	0.530	0.934	2.148	0.032
Gomes 2013	0.727	0.414	0.910	1.449	0.147
Kim 2014	0.862	0.685	0.947	3.403	0.001
Mostafa 2014	0.967	0.634	0.998	2.341	0.019
Honjo 2015	0.932	0.809	0.978	4.372	0.000
Ozogul 2015	0.632	0.403	0.813	1.133	0.257
Clerck 2016	0.941	0.680	0.992	2.690	0.007
	0.778	0.719	0.829	7.725	0.000

Pooled rate 77.8% (95% CI, 71.9–82.9)

Fig. 3 Forest plot showing etiologies of adult intussusception

Fig. 4 Forest plot showing malignant tumor rate according to location of intussusception
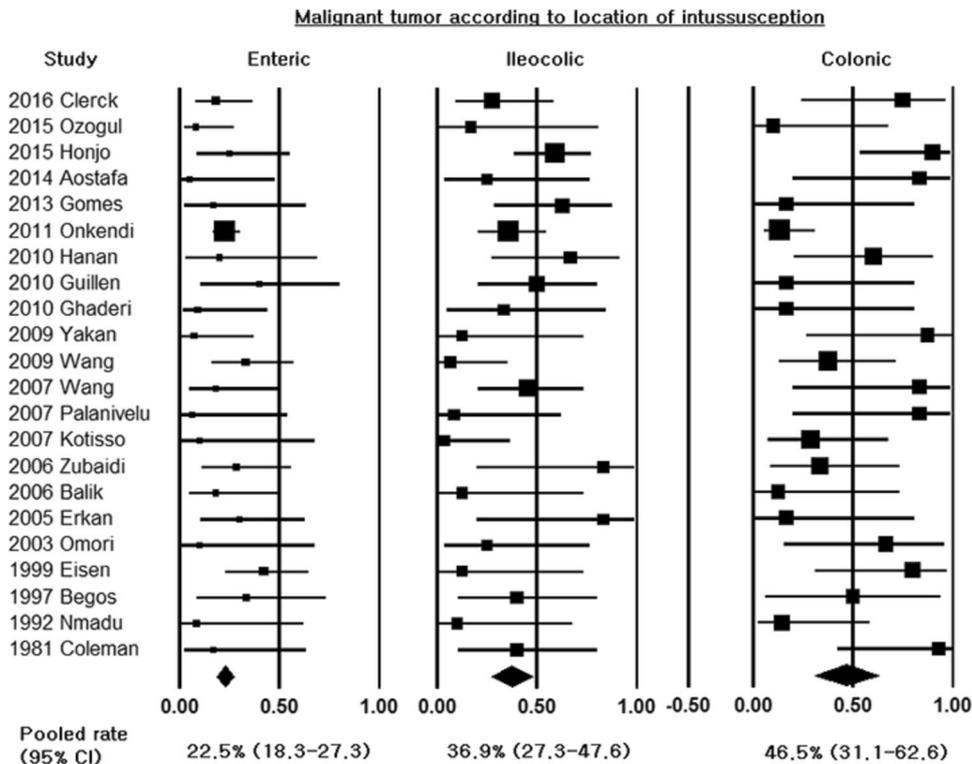
Table 3 Type of malignant tumor according to location

	Enteric (ref = 16)	Ileocolic (ref = 14)	Colonic (ref = 15)
Primary adenocarcinoma	16.6 (8.9–28.8)	61.7 (46.1–75.3)	78.8 (64–88.6)
Metastatic carcinoma	48.7 (31.8–66.0)	13.4 (6.6–25.0)	14.4 (7.3–26.4)
Lymphoma	26.2 (15.2–41.1)	28.1 (16.6–43.5)	16.8 (8.9–29.6)
GIST	21.3 (12.0–34.9)	14.8 (7.3–27.7)	0[a]
Others	23.1 (13.4–36.8)	16.0 (8.3–28.7)	0

The value in each item was described as a pooled rate (95% CI) of each proportion

GIST gastrointestinal stromal tumor

[a]0 indicate that there was no case in each study level

44]. Twenty-three deaths occurred among 755 patients who underwent surgery. The pooled rate of postoperative mortality was 5.2% (95% CI 3.7–7.4). Seventeen studies reported recurrence [2, 6, 8, 11, 13, 17, 18, 20, 24, 25, 28–30, 32, 37, 39, 44] although nine were unclear regarding duration of the follow-up period or had a follow-up period of < 1 year. At a follow up of > 1 year 16/349 patients in eight studies were noted to have suffered a recurrence [6, 18, 25, 28, 29, 32, 37, 44]. The pooled rate of recurrence for intussusception was 6.5% (95% CI 4.2–10.1).

Sensitivity analysis

When the impact of the study period was assessed, idiopathic cases slightly increased over time. The proportions of malignant and benign tumors were similar across the study periods. When geographic location was assessed, tropical nations had a lower proportion of malignant tumors and a higher proportion of idiopathic cases than non-tropical nations (Table 4).

Discussion

Adult intussusception is found in 1% of adult patients with bowel obstruction and represents < 5% of all cases of intussusception [23]. As adult intussusception is rare, prospective studies with controls are lacking. Although there are published reviews on adult intussusception [46–48], there are no systematic reviews with meta-analysis. Although all included studies were retrospective case series and had relatively low quality scores, our systematic review may help to summarize clinical features of this rare disease and suggest the best surgical plans for each type of intussusception.

CT scan was the most accurate preoperative diagnostic method compared to ultrasonography, small bowel series, barium enema, and colonoscopy, with a pooled accuracy of 77.8% (95% CI 71.9–82.9). Significant advancements in CT technology, along with progressive use of multi-detector CT (MDCT) in the diagnosis of abdominal emergencies, may help clinicians not only to differentiate intussusception from other abdominal emergencies, but also to avoid unnecessary surgery [49]. The distinction between lead point and non-lead point intussusception, as well as the detection of ischemic invaginated bowel, is important in deciding on surgical exploration. However, this review could not assess and report on the detection rate of lead points or ischemia on invaginated bowel with preoperative CT scan since most studies did not report these findings. Further research with emphasis on the role of CT technology is needed to obtain more accurate information and determine treatment plans.

While one study included 37 asymptomatic patients with incidentally diagnosed intussusception, most studies included only symptomatic patients. In this review, among 196 enrolled patients, 76 (including asymptomatic patients) had conservative treatment without surgery. In addition, the number of patients who had conservative treatment was very low. Hence, the pooled rate of conservative treatment was 4.6% (95% CI 2.7–7.7). Conservative treatment for adult intussusception has been less frequently performed

Table 4 Sensitivity analysis on the etiology of adult intussusception

	Number of studies	Malignant tumor	Benign tumor	Idiopathic
Total	40	32.9 (28.6–37.4)	37.4 (32.7–42.3)	15.1 (11.7–19.3)
Study period (years)				
< 2000	11	36.4 (29.0–44.5)	30.9 (24.1–38.7)	10.4 (4.8–24.1)
≥ 2000–2009	14	29.5 (23.4–36.5)	42.7 (35.4–50.4)	14.7 (9.1–22.9)
≥ 2010	15	34.1 (26.5–42.7)	37.1 (29.1–45.9)	18.9 (14.2–24.6)

Each value indicates a pooled rate and 95% confidence interval

considering that the pooled rate of idiopathic etiology was 15.1% (95% CI 11.7–19.3). This finding may be due to the retrospective nature of the study, which was based on chart review. Patients who did not undergo surgery or did not have specific symptoms might have not been diagnosed with intussusception. Surgeons may also still be of the opinion that adult intussusception should be operatively resolved. Given that CT technology has rapidly evolved and that the finding of idiopathic adult intussusception seems to have increased over time, emergent cases must be distinguished from non-emergent cases to identify patients who may benefit from conservative treatment.

Adult intussusception has been classified according to location and the presence of malignancy. In this review, most lesions were in the enteric location, with a pooled rate of 49.5% (95% CI 41.8–57.2). The main histological finding in malignant tumors in the enteric site was metastatic carcinoma (pooled rate, 48.7% and 95% CI 31.8–66.0), followed by lymphoma (pooled rate, 26.2% and 95% CI 15.2–41.1) and GIST (pooled rate, 21.3% and 95% CI 12.0–34.9). Conversely, the pooled rate of colonic location was 19.9% (95% CI 16.3–24.1). The main cause of colonic intussusception was primary adenocarcinoma (pooled rate, 78.8% and 95% CI 64–88.6), followed by lymphoma (pooled rate, 16.8% and 95% CI 8.9–29.6) and metastatic carcinoma (pooled rate, 14.4% and 95% CI 7.3–26.4). Considering the high rate of primary adenocarcinoma, colonic intussusception should be resected en bloc without reduction to avoid potential intraluminal seeding or venous tumor dissemination. Thirty-three studies that reported an opinion about whether or not reduction should be performed at surgery before resection. First, for most ileocolic intussusceptions, it is difficult to distinguish whether the lead point originates from the small bowel or colon. Preoperative CT scan or intraoperative palpation cannot identify the exact location of a lead point. Second, ileocolic intussusception has a lower incidence of primary adenocarcinoma than does colonic intussusception, but a much higher incidence than does enteric intussusception. Third, because of the constricting effect of the ileocecal valve, inappropriate attempts at surgical reduction can lead to bowel wall laceration and peritoneal soiling[18]. In this review, the most common cause of ileocolic intussusception was primary adenocarcinoma, with a pooled rate of 61.7% (95% CI 46.1–75.3). Among 16 studies reporting the surgical plan for ileocolic intussusception, ten recommended that ileocolic intussusceptions also be resected without attempting to reduce the invaginated bowel. In this type of intussusception, a more selective approach is needed. Initial reduction may be considered in select patients (those with no lead point on preoperative CT scan or intraoperative manipulation, those with a history of malignancy, or those with an easily reduced lesion) because limited enteric resection may be possible and will avoid the risks of colectomy [11, 18].

Unusual circumstances are possible: (1) patients in whom intestinal ischemia is highly suspected on preoperative CT scan or during the operation, (2) patients with long segments of intussuscepted bowel, and (3) patients with a polypoid mass in enteric intussusception, and (4) patients with colonic intussusception in tropical nations. Based on the incidence of intestinal ischemia (pooled rate, 15.0% and 95% CI 9.1–23.7), bowel viability must be assessed prior to reduction. In clinical situations in which bowel ischemia is in doubt, reduction should not be attempted, and en bloc resection of the segment will help limit contamination [13]. In patients with a long segment of intussuscepted bowel, reduction can be attempted until the invaginated bowel can be easily reduced to avoid extensive bowel resection. Specifically, in ileocolic and colonic intussusceptions with long invaginated segments, intraoperative colonoscopy may be helpful to distinguish benign from malignant lesions prior to reduction because most lesions lead distally and can be detected on colonoscopy [10]. In patients in whom a benign polypoid mass is suspected, initial reduction followed by enterotomy and polypectomy can be attempted. In patients with a history of Peutz-Jegher syndrome, enterotomy and polypectomy are preferred because of the recurrent nature of the intussusception [20, 32, 41]. When geographic location was assessed, tropical nations had a lower proportion of malignant tumors and a higher proportion of idiopathic etiologies compared to non-tropical nations. Hence, reduction may be an acceptable alternative for ileocolic or enteric intussusceptions in these geographic areas.

The pooled postoperative morbidity rate was 22.1% (95% CI 17.5–27.5), with the most common cause being surgical site infection. Although many studies did not report on surgical site infections in detail, some factors such as bowel edema, malnutrition, or emergent indication due to bowel obstruction could be attributable. In addition, most studies did not report detailed information relative to the causes of postoperative mortality. The pooled 5.2% (95% CI 3.7–7.4) mortality rate highlights the importance of the timing and type of surgery. For example, if bowel ischemia or sepsis is suspected, emergent resection should be promptly undertaken. If a patient with significant comorbidities has severe inflammation or bowel edema surrounding the intussusception, a resection with stoma rather than primary anastomosis may be advisable [18]. For patients who do not present with acute symptoms, the best perioperative care and thorough diagnostic assessment should precede surgery.

Information regarding recurrences following treatment of adult intussusception is very limited. Our review found a pooled recurrence rate of 6.5% (95% CI 4.2–10.1). However, interpretations should be cautious since only eight studies with a follow-up period of > 1 year were available [6, 18, 25, 28, 29, 32, 37, 44]. Five studies with 142 patients did not report any recurrences [18, 25, 28, 29,

37]. Only two studies reported detailed information about recurrence [6, 32]. Barussaud et al. [32] reported 3/44 patients with recurrence, one of whom was initially diagnosed with an idiopathic cause and underwent reduction. However, the patient was later diagnosed with recurrent intussusception induced by a Meckel's diverticulum. The other two patients had Peutz-Jeghers syndrome, both of whom repeatedly had initial reduction followed by enterotomy and polypectomy. Onkendi et al. [6] reported that among 21 patients who were initially asymptomatic and had conservative treatment, two patients experienced recurrence. Further studies regarding recurrence according to etiology, location, or surgical procedure need to be performed for adult intussusception.

This review had a number of limitations. First, the included studies had low levels of evidence as they were retrospective case series. Second, the studies had different exclusion criteria. Although all studies excluded rectal intussusception, rectal prolapse, and stoma site prolapse, some excluded intussusceptions related to prior surgery or incidental asymptomatic intussusception. Third, the method of reporting, including frequency of events such as complications or recurrence, was variable, making data pooling challenging. Pooled data of each value may not be the same as the relationships for individual patients within each study. Hence, conclusions drawn from this review need to be interpreted cautiously. Finally, this review could not draw any conclusions regarding surgical strategies for the ileocolic type intussusception. In this type of intussusception, a selective approach seemed to be best option considering the pooled results of this review.

Conclusions

Surgery remains the mainstay in adult intussusception. Enteric intussusception is the most common variety in adults and should generally be managed by initial reduction, followed by resection since the main causes of malignant tumor are metastatic carcinoma, lymphoma, and GIST. Colonic intussusception should be resected en bloc due to the high rate of primary adenocarcinoma. However, a selective approach seems appropriate for ileocolic adult intussusception because of its intermediate nature between enteric and colonic sites. Due to the increasing incidence of idiopathic etiologies combined with high postoperative morbidity and mortality, thorough diagnostic evaluation and medical optimiziation, should precede surgery in stable patients without an emergency indication for surgery.

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